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U. S. Navy Underwater Sound Laboratory
Fort Trumbull, New London, Connecticut

RESULTS OF ACCELERATION MEASUREMENTS MADE ON A MODIFIED AN/SQS-26 SONAR DOME SECTION

by

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INTRODUCTION

This memorandum presents the results of USL measurements taken on an AN/SQS-26 sonar dome section to determine if a particular modification reduces vibrations when the dome section is excited by sonar transmissions.

The purpose of the experiment that was conducted was to determine how an additional reinforcement in one panel of the dome section would affect the reverberant build-up of waves experienced by the dome window.

In January, 1965, USL performed a bending wave experiment on an AN/SQS-26 dome section. The results of this experiment which are presented in reference (a), showed that a reverberant build-up of waves occurs when the section is excited. In an attempt to reduce this build-up two recommendations were made:

(a) Alter the panel sizes of the dome window, and
(b) apply an acoustically transparent damping material to the dome window.

This memorandum discusses the first of the two recommendations. One panel, being representative of the panels of the SQS-26 dome section, was modified by welding a ½" dia. rod equidistant between two vertical trusses in order to reduce the panel size.

TEST SET-UP

Facilities

Of the two USL facilities (Dodge Pond Field Station and USL's South Pier) capable of being used for conducting the experiment, the South

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Pier Facility was the only one available. A detailed description of the test assembly is presented in reference (b).

During the course of the experiment, the noise level in the river was found to be negligible for these experiments.

Dome Section

An AN/SQS-26 dome section (USL #158) 4 feet by 4 feet with approximately 10 inch vertical and 11-3/16 inch horizontal spacings between the trusses, welded as shown in figure 1 was used as a reference. The same dome section was modified by welding a 0.5 inch diameter rod vertically in the center of panel 13, as shown in figure 2.

Accelerometers

Endevco Model 2217 piezoelectric accelerometers with Belden 8428 cable, a neoprene jacketed shielded pair cable, were employed. Accelerometers for different measurements were placed at various positions on the dome section as shown in figures 3, 4, and 5. In these figures, the intersection of the x and y axes is at the center of the dome section; the dotted lines represent the locations of the trusses supporting the dome window on the inside.

Figure 3 shows the positions of 10 accelerometers. All the accelerometers were located horizontally a distance of 2.5 inches above the x-axis. Accelerometer #1 was located on the y-axis. The other accelerometers were evenly spaced across the panel. Accelerometer #10 was located over the next vertical truss to the right. This figure shows the locations of the accelerometers for both the reference dome section and the modified dome section.

Figure 4 shows the locations of 10 accelerometers positioned in the vertical plane at a distance of 5.75 inches from the y-axis on the reference dome section. Accelerometer #1 is on the x-axis. The accelerometers extend vertically to accelerometer #10 which is placed over the next horizontal truss above.

Figure 5 illustrates the positions of 10 accelerometers located vertically and 5.75 inches to the right of the y-axis of the modified dome section; these locations are where the vertical 0.5 inch dia. bar was located.

Adhesive and Waterproofing

The accelerometers were bonded to the dome section with Armstrong A-2 Adhesive mixed with Activator A. The waterproofing agent was

G. E. RTV60 applied over a G. E. Silicone Primer XS-4004.

Before installation of the accelerometers, the surfaces of the dome and accelerometer bases were cleaned with acetone, a metal conditioner and a neutralizer. After the adhesive was applied and the cure cycle was completed the primer was first applied, after which the waterproofing agent was applied and allowed to cure.

PROCEDURE

Measurements were made at a water depth of 12 feet in the Thames River (salt water). Before the dome section was excited by the transducer array, it was lowered into the water and allowed to soak.

A General Radio Type 1553 Vibration Meter was used in taking the measurements. The array was driven at a level below the onset of cavitation throughout the experiment and at the SQS-26 sonar frequency. 5 second pulses at intervals of 5 seconds were used to suit the stabilization requirements of the instrumentation that was used.

Readings were first taken of the accelerometers that were in the horizontal and vertical planes of the reference dome section. The 0.5 inch diameter rod was then welded in place and the readings repeated.

RESULTS

Figures 6 and 7 show accelerations in peak g's measured by the accelerometers. Displacements shown in figures 6 and 7 were calculated from the measured accelerations using the relationship

$$D = \frac{a}{\omega^2}(10)^3$$

where D = peak displacement (mils)

a = peak acceleration (inches/second^2)

w = circular frequency (radians/second).

Figure 6 is a plot of the average values of accelerations in peak g's vs. vertical distance from the x-axis. Accelerations with and without the welded rod are both shown. Without the rod, the maximum average acceleration is 216.28 peak g's as compared to 360.65 peak g's with a rod.

Figure 7 is a plot of the average values of acceleration in peak g's vs. horizontal distance from the y-axis. Readings taken with and without the welded rod are both plotted. The maximum average value of accelerations without a rod is 316.38 peak g's as compared to 256 peak g's with a rod. However, the accelerations with the bar are generally higher than the accelerations without the bar, see figure 7.

Tables 1, 2, 3, and 4 present all the readings from which figures 6 and 7 were plotted.

DISCUSSION

From this experiment, it is believed that further addition of stiffeners to the dome section offers no advantage. In fact, the amplitude of the accelerations due to the reverberant build-up of waves after the installation of the rod noticeably exceeded those of the dome section without the rod.

This is due to the fact that the welded rod was probably acting as an additional source of bending waves as well as a reflector and transmitter of bending waves generated at the trusses. These waves would cause a further increase in the reverberant accelerations since they would add to the waves already generated at the trusses.

RECOMMENDATIONS

Since addition of stiffeners to the dome section has been proven to be unsatisfactory, the work being done on acoustically transparent damping material should be considered as the next most advantageous approach for reducing the reverberant build-up of free waves in the dome window.

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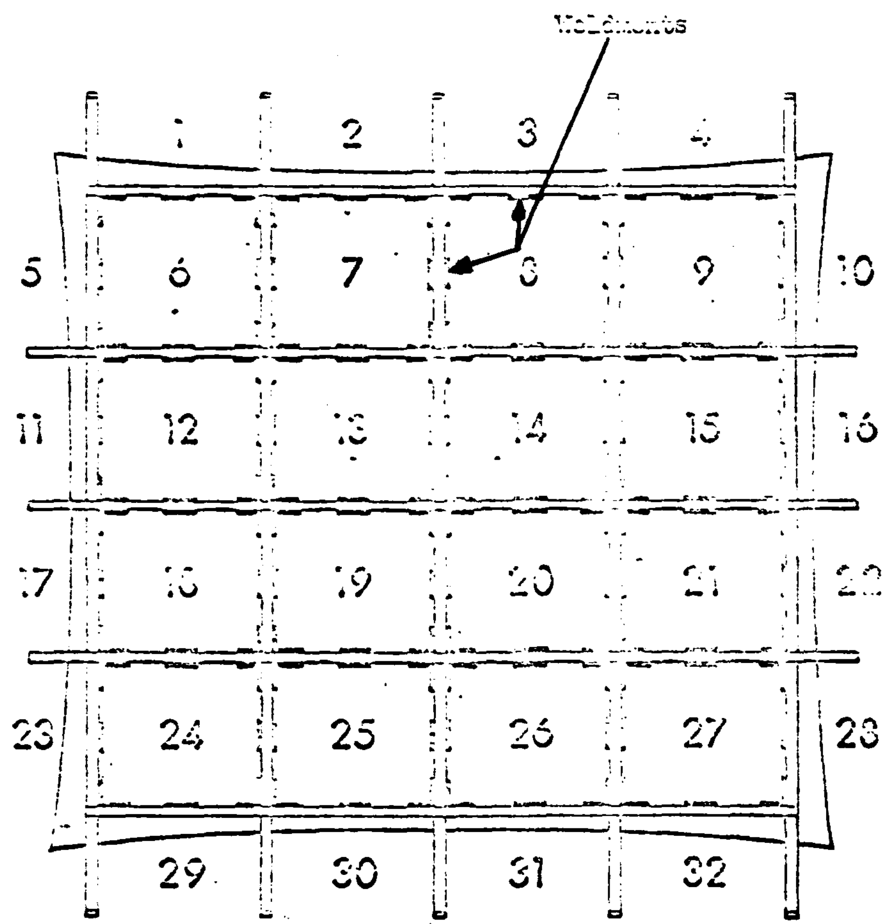
LIST OF REFERENCES

(a) H. N. Phelps, Jr. and P. E. Seaman, "Results of a Bending Wave Experiment Performed on an AN/SQS-26 Sonar Dome Section", USL Technical Memorandum No. 933-0136-65, 8 July 1965 (CONFIDENTIAL)

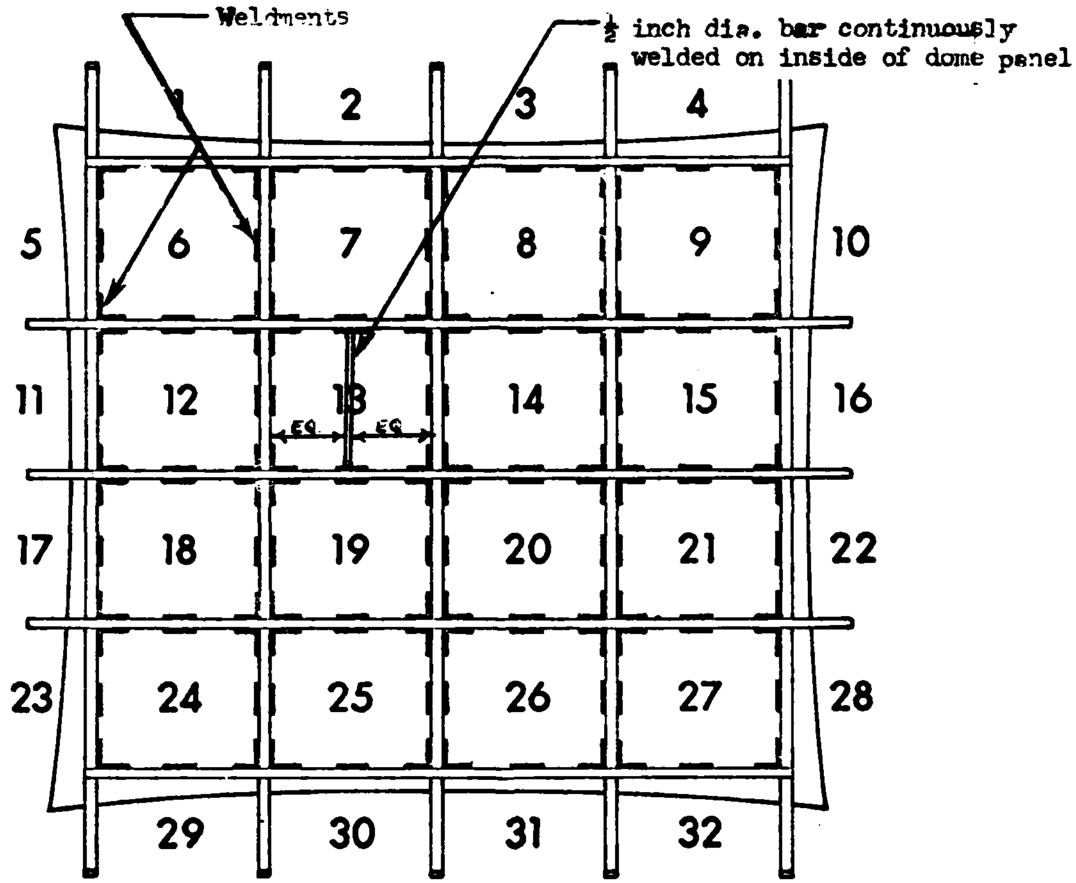
(b) Natwick, J. O., "Test Method for Evaluating Sonar Dome Coatings", USL Technical Memorandum No. 933-0153-64, 19 June 1964 (CONFIDENTIAL)



SCS-26 Dome Section's Weld Pattern

Figure 1

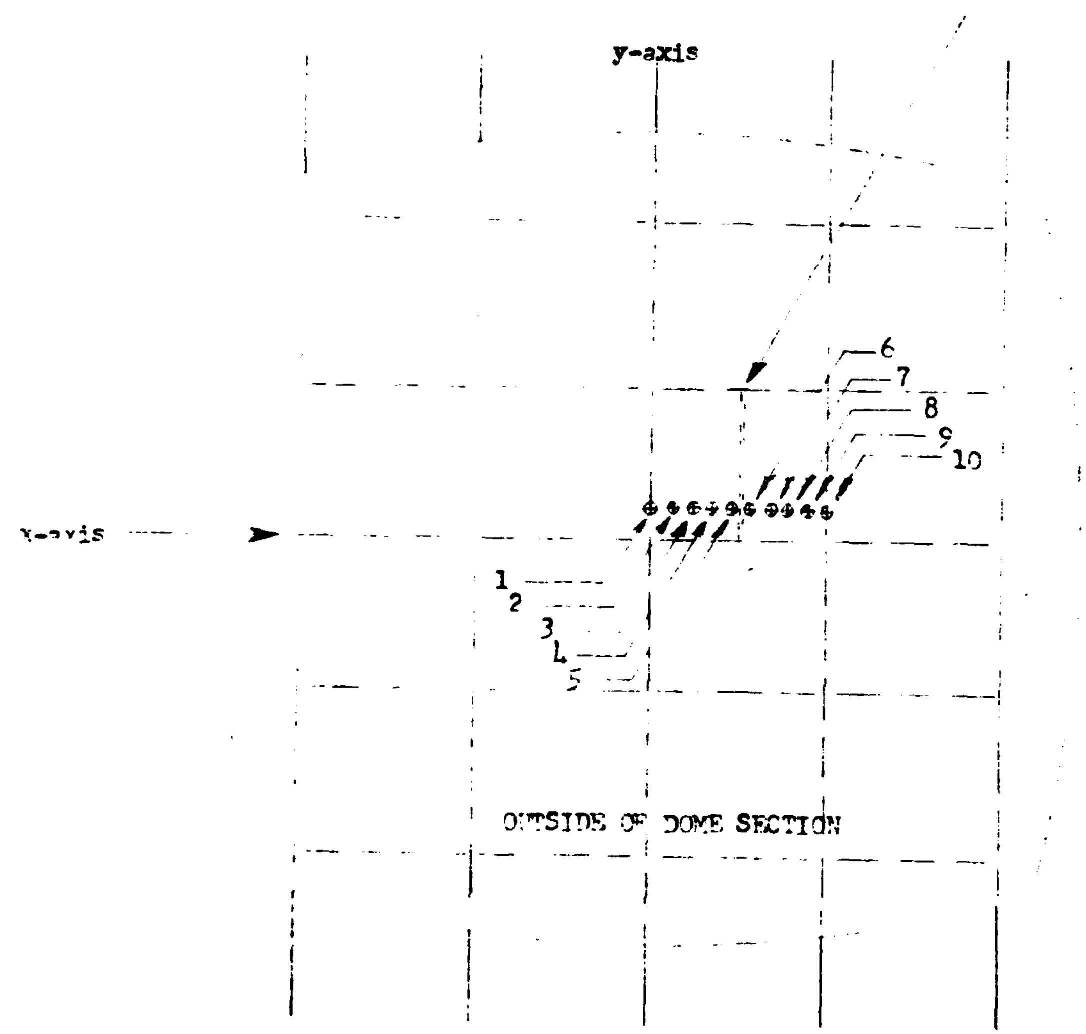
USL Tech. Memo. No. 933-11-66



SCS-26 Dome Section Weld Pattern

Figure 2

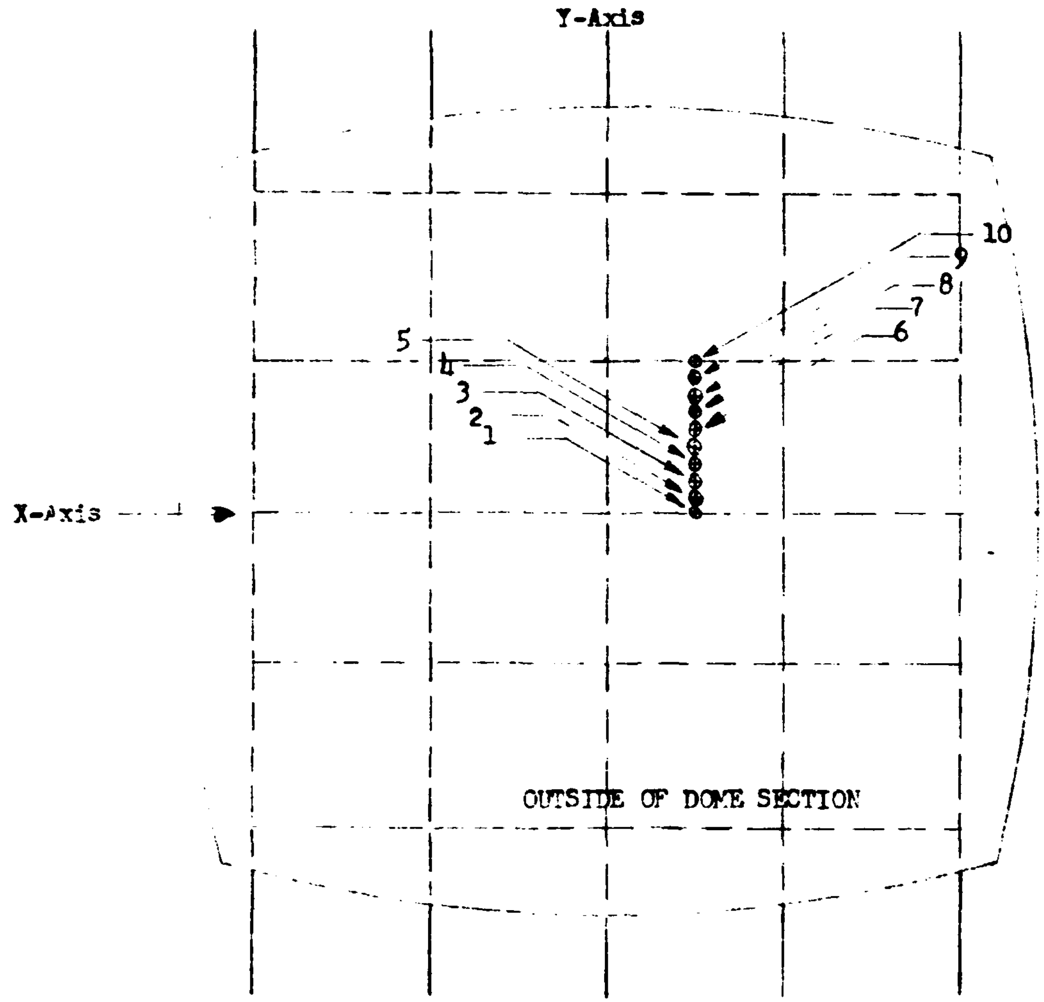
Accelerometer Positions for Data Shown in Figure 7



Accelerometer Number	Distance from y-axis (inches)	Distance from x-axis (inches)
1	0	2.5
2	1.25	2.5
3	2.50	2.5
4	3.75	2.5
5	5.00	2.5
6	6.25	2.5
7	7.50	2.5
8	8.75	2.5
9	10.00	2.5
10	11.25	2.5

Figure 3

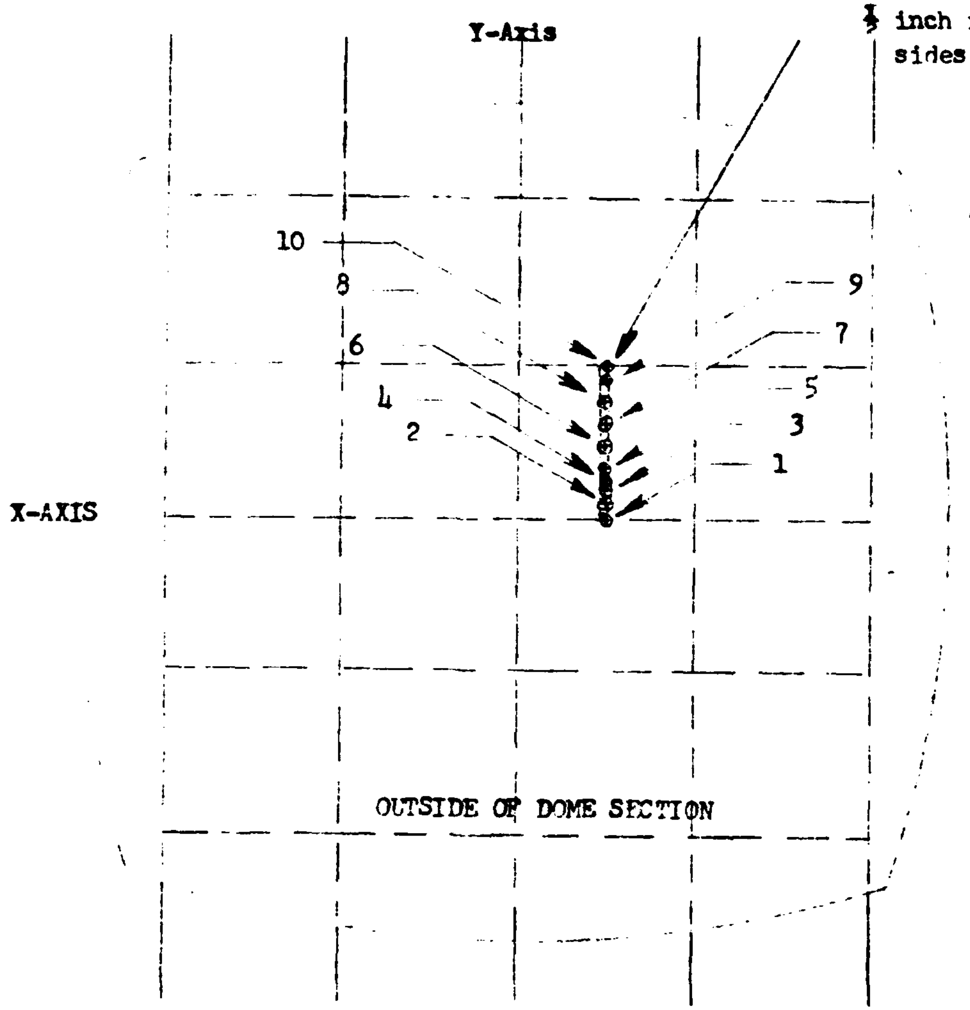
Accelerometer Positions for Data Shown in Figure 6.



Accelerometer Number	Distance from y-axis (inches)	Distance from x-axis (inches)
1	5.75	0
2	5.75	1.16
3	5.75	2.33
4	5.75	3.50
5	5.75	4.67
6	5.75	5.83
7	5.75	7.00
8	5.75	8.17
9	5.75	9.33
10	5.75	10.50

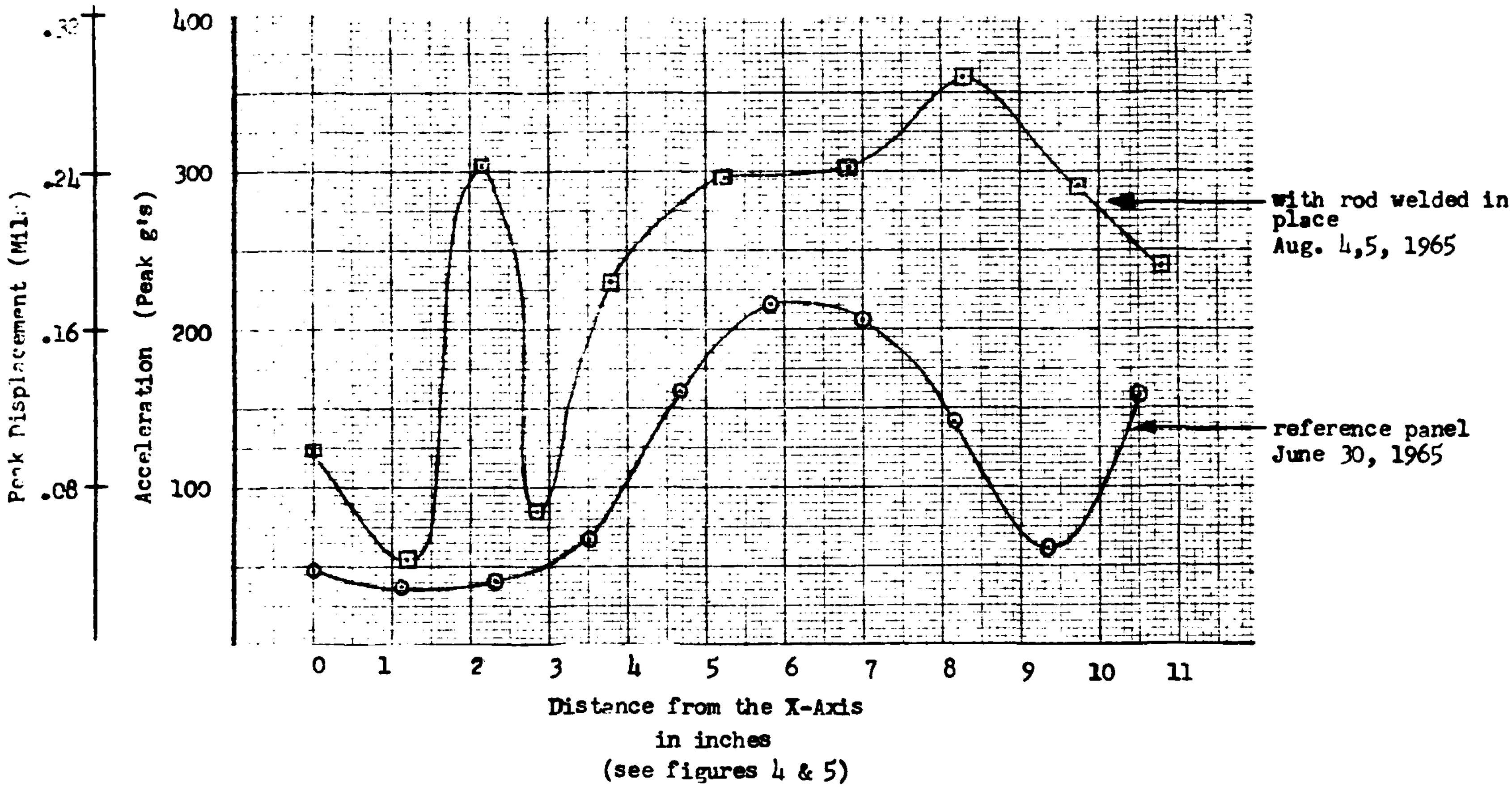
Figure 4

Accelerometer Positions for Data Shown in Figure 6.



Accelerometer Number	Distance from y-axis (inches)	Distance from x-axis (inches)
1	5.75	0
2	5.75	1.20
3	5.75	2.15
4	5.75	2.85
5	5.75	3.80
6	5.75	5.25
7	5.75	6.83
8	5.75	8.28
9	5.75	9.73
10	5.75	10.80

Figure 5



.32
.24
.16
.08
Peak Displacement (Mils)
400
300
200
100
Acceleration (Peak g's)
0
1
2
3
4
5
6
7
8
9
10
11
Distance from the X-Axis
in inches
(see figures 4 & 5)
with rod welded in place
Aug. 4,5, 1965
reference panel
June 30, 1965

Figure 6

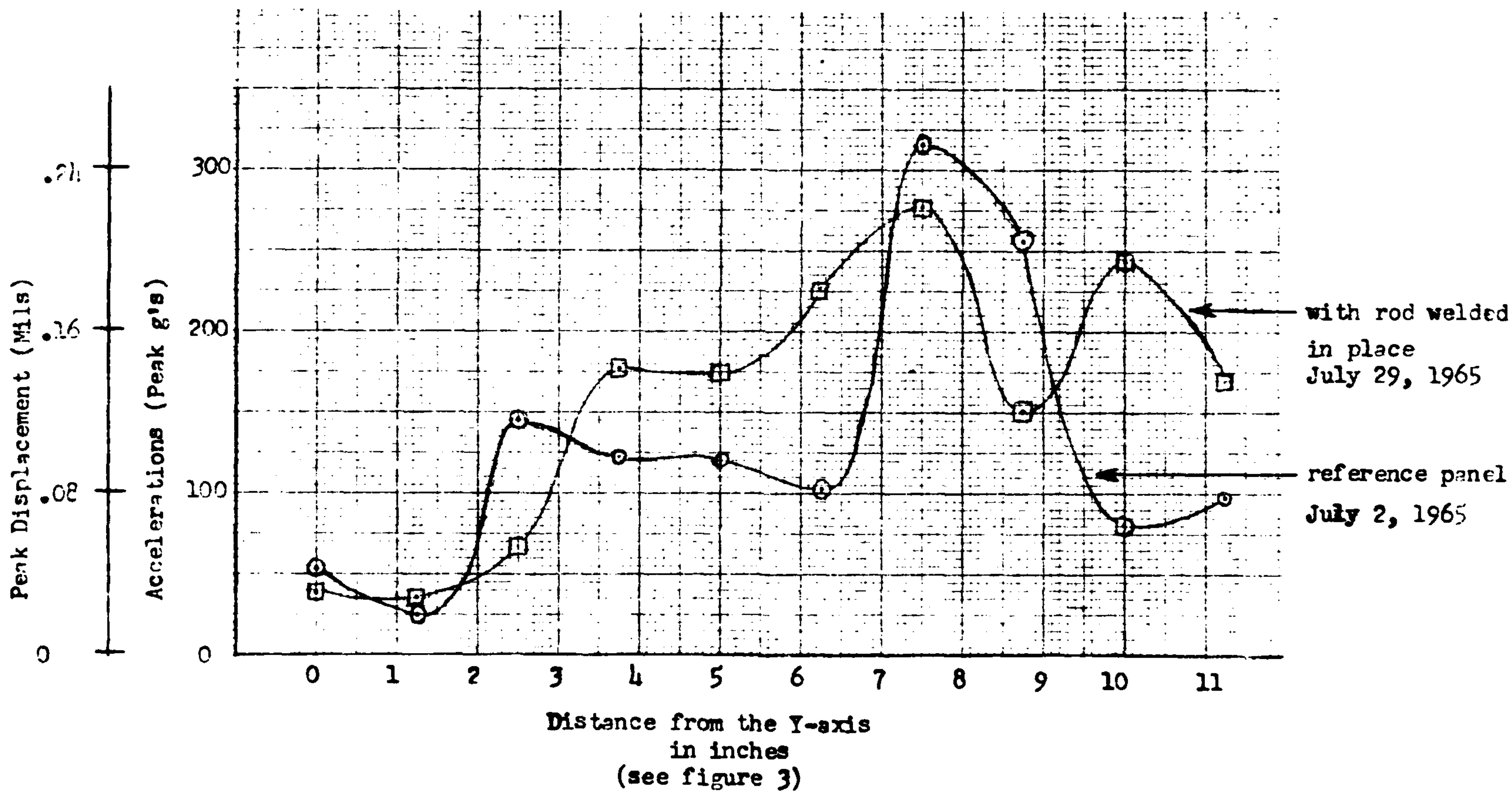

Peak Displacement (Mils)
.24
.16
.08
0
Accelerations (Peak g's)
300
200
100
0
0
1
2
3
4
5
6
7
8
9
10
11
Distance from the Y-axis
in inches
(see figure 3)
with rod welded
in place
July 29, 1965
reference panel
July 2, 1965

Figure 7

TABLE 1

Amplitudes of Acceleration (Peak g's) for the Reference Dome Section with

Accelerometers Placed Horizontally (See Figure 3). July 2,1965

Accelerometer Number

		1	2	3	4	5	6	7	8	9	10
Runs	1	52.41	41.59	195.65	149.73	136.54	121.12	407.61	326.09	52.94	148.22
	2	49.50	29.12	167.70	149.73	120.47	121.12	372.67	391.30	61.41	76.23
	3	53.86	21.63	149.07	108.14	136.54	121.12	407.61	251.55	50.82	63.52
	4	61.14	20.80	121.12	108.14	136.54	111.80	271.27	204.97	116.46	137.63
	5	52.41	20.80	121.12	108.14	112.44	72.67	232.91	177.02	82.58	82.58
	6	56.05	19.13	121.12	108.14	88.35	68.01	256.21	186.34	116.46	84.98
Average		54.23	25.51	145.96	122.00	121.81	102.64	316.38	256.21	80.11	98.86

TABLE II

Amplitudes of Acceleration (Peak g's) for the Test Dome Section with the Accelerometers Placed Horizontally (See Figures 3 & 7).

July 29, 1965

Accelerometer Number

		1	2	3	4	5	6	7	8	9	10
Runs	1	42.12	29.12	69.88	149.73	155.97	251.55	267.86	159.39	243.51	179.98
	2	45.86	29.95	69.88	183.01	171.57	223.60	267.86	158.39	264.27	190.57
	3	37.85	45.75	63.35	174.69	194.67	195.65	256.21	139.75	243.51	137.63
	4	42.32	43.26	69.88	158.05	202.77	270.19	337.73	167.70	243.51	169.40
	5	30.57	36.60	68.01	232.92	140.38	251.55	314.44	149.07	243.51	158.81
	6	38.58	35.77	63.35	166.37	179.37	177.02	221.27	130.44	222.33	179.98
Average		39.55	36.74	67.39	177.46	174.12	228.26	277.56	150.62	243.44	169.39

TABLE III

Amplitudes of Acceleration (Peak g's) for the Reference Dome Section with the Accelerometers Placed Vertically (See Figures 4 & 6).

June 30, 1965

Accelerometer Number

Runs	1	2	3	4	5	6	7	8	9	10
1	42.22	40.76	48.45	59.89	136.54	195.65	174.69	172.36	61.41	149.40
2	45.13	36.30	68.94	56.57	184.73	223.60	256.21	130.43	74.11	179.98
3	53.86	27.45	65.22	56.57	200.48	251.55	244.57	158.39	69.88	188.45
4	38.58	39.93	18.63	34.94	136.54	158.39	244.57	102.48	50.82	137.63
5	52.41	23.29	13.98	33.27	136.54	158.39	221.27	102.48	61.41	148.22
6	49.50	51.58	38.13	124.78	152.60	270.19	128.11	167.70	60.35	137.63
7	50.95	39.93	39.13	108.14	184.73	256.21	174.69	158.39	60.35	148.22
Average	47.52	37.08	41.93	67.74	161.74	216.28	206.63	141.75	62.62	158.50

TABLE IV

Amplitudes of Acceleration (Peak g's) for the Test Dome Section with the Accelerometers Placed Vertically (See Figures 5 & 6). Aug. 4 & 5, 1965

Accelerometer Numbers

	1	2	3	4	5	6	7	8	9	10
Run 1	123.74	45.75	251.55	99.82	224.38	214.29	314.44	354.04	254.09	232.92
2	87.34	49.91	242.24	141.42	239.34	242.24	232.92	279.50	254.09	232.92
3	69.15	33.27	186.34	99.82	184.73	232.56	337.73	503.11	307.03	264.27
4	211.08	66.55	484.47	58.23	192.76	251.55	244.57	307.45	275.27	116.46
5	123.74	41.59	307.45	54.07	216.85	298.12	361.02	354.04	307.03	254.09
6	131.02	74.87	316.77	74.87	329.29	442.22	302.80	437.89	359.97	307.03
7	123.74	66.55	335.40	70.71	224.89	391.30	326.09	288.81	285.85	275.27
Average	124.26	54.07	303.46	85.56	230.39	296.01	302.80	360.69	291.90	240.12